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Filed : February 11, 2002

REMARKS

Applicant has received the Office Action of October 4, 2004 ("Office Action"). Claims 1-15 and 20-33 are currently pending in this application.

Amendments to the Claims

The Amendments to the Claims set forth above amend Claim 1 to recite a higher-order silane of the formula $\text{Si}_n\text{H}_{2n+2}$, wherein $n = 3-6$, and amends Claim 2 to delete "disilane." These changes are supported throughout the specification, *see*, e.g., paragraph 0034.

Applicant reserves the right to file divisional and/or continuation applications containing claims directed to all or part of the subject matter described in the instant application, including the subject matter of any claims amended or canceled at any time during the prosecution of this application, and thus unclaimed subject matter is not dedicated to the public

Information Disclosure Statements (IDS's)

Applicant understands that the Office has received and considered the references submitted by Applicant with the IDS's filed on June 24, 2004 and May 8, 2002. However, Applicant has not received initialed copies of the PTO-1449 forms submitted with the IDS's filed on September 10, 2004, August 19, 2003, May 6, 2003, and November 25, 2002, and respectfully requests that such copies be provided with the next Office Action. Courtesy copies of the IDS's filed on August 19, 2003, May 6, 2003 and November 25, 2002 were enclosed with the Amendment filed on June 24, 2004 and appear to have been considered by the Office, *see* Office Action at 2-3, but initialed copies of the corresponding PTO-1449 forms have not been received. Applicant will provide additional copies on request.

Withdrawal of Prior Rejections

Applicant notes that the previously stated rejection of Claims 1-15 and 20-33 under 35 U.S.C. § 103(a) as being unpatentable over Rolfson (U.S. Patent No. 5,786,027) in view of U'Ren (U.S. Patent No. 6,365,479) appears to have been withdrawn by the Office.

Applicant respectfully points out that this Office Action and prior Office Actions contain a number of errors and inaccuracies. Applicant has and will respond to or point out a number of these errors and inaccuracies, but for brevity Applicant has not and will not respond to all of

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them. Applicant reserves the right to respond to or point out a particular error or inaccuracy at a later time, and the absence of such a response is not to be construed as acquiescence.

Claim Rejections - 35 U.S.C. § 102(e)

Claims 1-5 have been rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,210,988 ("Howe"). The Office has taken the position that Howe discloses introducing a gas comprising a higher-order silane and a germanium precursor to the chamber. *See* Office Action at 4. Applicant respectfully disagrees. The portion of Howe cited by the Office refers specifically to the use of silane or disilane, not generally to the use of higher-order silanes. Claim 1 has now been amended to recite a higher-order silane of the formula $\text{Si}_n\text{H}_{2n+2}$, wherein $n = 3-6$. Since Howe does not disclose such a silane, Applicant respectfully requests reconsideration and withdrawal of this rejection.

Claim Rejections - 35 U.S.C. § 103(a)

Claims 4 and 6-10 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Howe as applied to Claims 1-3 above and over Rolfson (U.S. Patent No. 5,786,027). Claims 11-15 and 20-33 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Howe in view of Rolfson as applied to the claims above and further in view of U'Ren (U.S. Patent No. 6,365,479). Applicant respectfully traverses these rejections for the reasons discussed below.

Scope and Content of the Prior Art

In assessing obviousness, the Office is required to properly determine the scope and content of the prior art. *See* M.P.E.P. § 2141.01. The Office states that "Howe describes higher-order silanes without specifically mentioning trisilane." *See* Office Action at 5. Applicant respectfully disagrees because Howe only refers to silane and disilane, not generally to higher-order silanes. Applicant respectfully submits that this statement by the Office reflects a misunderstanding of the scope and content of Howe, and that the rejection of Claims 4, 6-10, 11-15 and 20-33 under 35 U.S.C. § 103(a) is due at least in part to an erroneous obviousness analysis based on a misunderstanding of Howe. Therefore, Applicant respectfully requests reconsideration and withdrawal of this rejection.

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All Claim Limitations Not Taught or Suggested

"To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art." M.P.E.P. § 2143.03 (citing *In re Royka*, 490 F.2d 981, 180 USPQ 580 (C.C.P.A. 1974)). In rejecting Claim 10, the Office refers to Rolfson at 1:44-56 for the disclosure of the recited single-wafer, horizontal gas flow reactor. *See* Office Action at 6. However, Rolfson only generally discloses deposition by LPCVD, and does not specifically teach or suggest the recited single-wafer, horizontal gas flow reactor. Therefore, Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 10.

No Motivation to Combine Howe and Rolfson

There is no *prima facie* case of obviousness in the absence of a motivation to combine the cited references. *See* M.P.E.P. § 2143. The Office must consider the prior art as a whole when evaluating motivation: "A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." M.P.E.P. § 2121.03 (emphasis in original). The Office must consider "all teachings in the prior art . . . to the extent that they are in analogous arts." M.P.E.P. § 2143.01.

The Office acknowledges that Howe does not disclose trisilane, but notes that Rolfson discloses the use of higher-order silanes to deposit thin films with discontinuous and randomly oriented grain boundaries. *See* Office Action at 5; Rolfson at 2:57-67. With respect to Claims 4 and 6-10 and the motivation to combine Howe and Rolfson, the Office states:

[I]t would have been obvious to one of ordinary skill in the art at the time of the invention to include Rolfson's higher silane namely trisilane in Howe's method. the [sic] motivation to make the above substitution is to provide an improved method of depositing films that enable a manufacturer to produce more stable devices with discontinues [sic] and randomly oriented grain boundary layers and also random, polycrystalline grain structure.

Office Action at 5. Thus, with respect to Claims 4 and 6-10, the motivation alleged by the Office is to enable the production of films having the properties disclosed by Rolfson. *See* Rolfson at 2:43-45.

Applicant respectfully disagrees because one skilled in the art at the time of the claimed invention would not have been motivated to combine Howe and Rolfson to meet the instant

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claims. The evidence of record establishes that those skilled in the art would have believed that the germane used in Howe's method would make it more difficult to achieve the properties desired by Rolfson because the presence of germane would undesirably increase the surface roughness of the resulting SiGe film, undesirably increase the formation of grain boundaries that extend from the surface of the film to the underlying substrate, and undesirably reduce the effective difference in sticking coefficients between the silicon sources. Therefore, Applicant respectfully submits that the Office has not established a *prima facie* case of obviousness. See M.P.E.P. § 2143.

Applicant respectfully directs the attention of the Office to the Declaration of Dr. Michael A. Todd Under 37 C.F.R. § 1.132 ("Todd Declaration"), previously submitted to the Office on June 24, 2004. The Office is respectfully invited to refer to the text of the Todd Declaration for the details of the facts and technical reasoning supporting the conclusions summarized below.

Dr. Todd is skilled in the art of semiconductor fabrication and has carefully reviewed Rolfson. See Todd Declaration at ¶¶ 1-2. Considered as a whole, Rolfson teaches the undesirability of film surface roughness and grain boundaries that extend from the surface of the film to the underlying substrate. See Todd Declaration at ¶¶ 3-6. Those skilled in the art at the time of the invention were generally aware that the addition of germane to a silane-based CVD process increased the roughness and the depth of the grain boundaries in the resulting SiGe film. See Todd Declaration at ¶ 8-10.

Thus, the evidence of record establishes that one skilled in the art at the time of the claimed invention would not have been motivated to combine Rolfson and Howe because it was generally believed that the use of germane would produce films having properties considered undesirable by Rolfson, i.e., increased surface roughness, larger average grain size, and increased formation of grain boundaries that extend from the surface of the film to the underlying substrate. See Todd Declaration at ¶ 8.

Rolfson is directed to a low pressure CVD process in which at least two silicon source gases having different adsorption characteristics (termed "sticking coefficients") are used to grow a polysilicon thin film on a substrate. See Todd Declaration at ¶¶ 5, 11. The reason for using two different silicon source gases is to form a polycrystalline film with grain boundaries that are not continuous across the full thickness of the film. See Todd Declaration at ¶¶ 5, 11. Thus, the Rolfson CVD process favors the use of silicon sources having sticking coefficients with

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relatively large differences from one another. *See* Todd Declaration at ¶ 11. Those skilled in the art understood that the relative difference in sticking coefficient between one silicon source and another was effectively reduced (contrary to the goals of Rolfson) when the silicon sources were in the presence of a germanium source in a CVD process. *See* Todd Declaration at ¶ 12.

Thus, the evidence of record establishes that one skilled in the art at the time of the claimed invention would not have been motivated to combine Rolfson and Howe because one skilled in the art would have believed that the use of a germanium source would reduce the effective difference in sticking coefficients between the silicon sources, thereby undesirably reducing the likelihood of achieving discontinuous and randomly oriented grain boundaries. *See* Todd Declaration at ¶ 13.

The Office has not disputed the facts and technical reasoning set forth in the Todd Declaration, but appears to have taken the position that they are "moot in view of the new ground(s) of rejection." *See* Office Action at 9. Applicant respectfully disagrees because the facts and technical reasoning in the Todd Declaration are relevant to the current rejections. For example, ¶ 12 of the Todd Declaration states that those skilled in the art were generally aware that the addition of germane to a silane-based CVD process increased the roughness and the depth of the grain boundaries in the resulting SiGe film. This undisputed fact is relevant to the current § 103 rejection over the combination of Howe and Rolfson for the reasons discussed above.

With respect to Claims 11-15 and 20-33 and the motivation to combine Howe, Rolfson, and U'Ren, the Office refers to Claim 11 and recognizes that Howe and Rolfson fail to disclose a SiGe-containing film having a thickness non-uniformity of about 10% or less as claimed. However, the Office states:

U'Ren . . . describes an important consideration is that the film be conformal and smooth i.e. non-uniformity is less than 10%, so that the strain between the silicon and silicon-germanium crystals does not exceed the critical level which in turn ensures good control over the desired profiles of the multiplayer [sic] collector-base-emitter stack so produced. (U'Ren col. 4, 5, 6). Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to include U'Ren's teaching of thickness non-uniformity of about 10% or less in Howe and Rolfson's processes. The motivation to make the above combination is so that the strain between the silicon and silicon-germanium crystals does not exceed the critical level which in turn ensures good control over the desired profiles of the multiplayer [sic] collector-base-emitter stack so produced. (U'Ren col. 4, 5, 6).

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See Office Action at 7. The Office Action refers to various limitations of Claims 12-33 allegedly met by U'Ren, but does not allege any additional motivation to combine Howe, Rolfson, and U'Ren with respect to Claims 12-33. Thus, the only motivation to combine Howe, Rolfson, and U'Ren alleged by the Office is "that the film be conformal and smooth i.e. non-uniformity is less than 10%, so that the strain between the silicon and silicon-germanium crystals does not exceed the critical level." See Office Action at 7.

Applicant respectfully submits that U'Ren does not teach or suggest that a smooth underlying film reduces strain between Si and SiGe as alleged by the Office. The only passage in U'Ren that refers to a smooth film reads as follows: "Moreover, desirable characteristics of a polycrystalline material include that it be conformal and smooth so that it is easy to deposit high integrity layers on top of the polycrystalline material." See U'Ren at 7:61-64. This passage does not associate smoothness with strain, and the Office has provided no technical reasoning to support any such association.

Lacking such an association, any motivation to produce a "conformal and smooth" film as alleged by the Office is far too vague and generalized to meet the requirement of specificity that has long been imposed by the Court of Appeals for the Federal Circuit. A *prima facie* case of obviousness requires "some motivation, suggestion, or teaching of the desirability of making the specific combination that was made by the applicant." *In re Sang-Su Lee*, 277 F.3d 1338, 1343 (Fed. Cir. 2002) (emphasis added, citing *In re Dance*, 160 F.3d 1339, 1343 (Fed. Cir. 1998)). "The need for specificity pervades this authority." *Id.* (emphasis added, citing *In re Kotzab*, 217 F.3d 1365, 1371 (Fed. Cir. 2000)). U'Ren does not teach achieving smoothness by a method involving the claimed combination of limitations, including a higher-order silane of the formula $\text{Si}_n\text{H}_{2n+2}$ and a germanium precursor, and thus fails to provide the degree of specificity required to establish *prima facie* obviousness.

In addition, Applicant respectfully submits that one skilled in the art would not be motivated to combine U'Ren and Rolfson for the reasons previously explained in detail in the Todd Declaration and the Amendment submitted June 24, 2004 (hereby incorporated by reference). The Office has not disputed those reasons, but appears to have taken the position that they are "moot in view of the new ground(s) of rejection." See Office Action at 9. Applicant respectfully disagrees because the addition of Howe does not negate the previously established

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lack of motivation to combine Rolfson and U'Ren. The Office does not cite any portion of Howe to support the alleged motivation to combine, and thus the previously established lack of motivation has not been disputed by the Office.

Therefore, because the Office has failed to establish a *prima facie* case of obviousness, Applicant respectfully requests reconsideration and withdrawal of the rejection of Claims 4 and 6-10 under 35 U.S.C. § 103(a) as being unpatentable over Howe as applied to Claims 1-3 above and over Rolfson, and the rejection of Claims 11-15 and 20-33 under 35 U.S.C. § 103(a) as being unpatentable over Howe in view of Rolfson as applied to the claims above and further in view of U'Ren.

Unexpected Results

Applicant respectfully submits that the above-captioned patent application contains significant evidence of unexpected results that have not be properly evaluated by the Office. Applicant respectfully directs the attention of the Office to the Amendment filed June 24, 2004, which is hereby incorporated by reference, and particularly to the section beginning at page 12 of the Amendment entitled "Unexpected Results."

In the Office Action issued October 4, 2004 the Office has not disputed these unexpected results, but appears to have taken the position that they are "moot in view of the new ground(s) of rejection." *See* Office Action at 9. Applicant respectfully disagrees because the unexpected results are directed to the combination recited in the claims (which remain pending regardless of the Examiner's grounds for the obviousness rejections) and thus must be considered by the Office: "Objective evidence or secondary considerations such as unexpected results . . . are relevant to the issue of obviousness and must be considered in every case in which they are present. When evidence of any of these secondary considerations is submitted, the examiner must evaluate the evidence." M.P.E.P. § 2141 (emphasis added). Applicant respectfully submits that the rejection of Claims 4 and 6-10 under 35 U.S.C. § 103(a) is due at least in part to an erroneous obviousness analysis based on an admitted failure by the Office to consider the unexpected results. Therefore, Applicant respectfully requests reconsideration and withdrawal of this rejection.

The Office has taken the position that "either the application including the claims (when the claims are given their broadest possible meaning) and specification contain a false declaration

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or the! [sic] 32 declaration is false.” *See* Office Action at 10. Applicant strenuously disagrees because the two positions referred to in the Office Action are entirely consistent and, in fact, are further evidence of unexpected results. In particular, the Office states that Applicant Michael Todd “stated under oath in the specification claims 21 and 23 ‘wherein the graded SiGe-containing film is deposited at a deposition rate that is a substantially linear function of the amount of germanium precursor.’” *See* Office Action at 9-10. The Office further states that “[i]n direct contrast and the exact opposite position have been declared to” by Applicant Michael Todd in ¶ 26 of the Todd Declaration. *See* Office Action at 10. In particular, the Office quotes (erroneously) a portion of ¶ 26 as stating “the germane film concentration in the SiGe film is not a linear function of the germane concentration in the gas phase when using either silane or disilane as the silicon source.” *See* Office Action at 10.

As an initial matter, Applicant notes that the Office has incorrectly stated that Claim 21 recites “wherein the graded SiGe-containing film is deposited at a deposition rate that is a substantially linear function of the amount of germanium precursor.” That phrase is recited in Claim 23, not Claim 21. Claim 21 recites “wherein the amounts are varied to produce a germanium concentration that is a substantially linear function of the amount of germanium precursor.” *See* Claims 21 and 23. In addition, Applicant notes that the Office misquoted the Todd Declaration at ¶ 26 by erroneously substituting the word “germane” for “germanium” and by erroneously inserting the word “film” between the words “germane” and “concentration.” The correct partial quotation is: “the germanium concentration in the SiGe film is not a linear function of the germane concentration in the gas phase when using either silane or disilane as the silicon source.” *See* Todd Declaration at ¶ 26.

The Office has also apparently misread independent Claim 20, which recites a process “using a deposition gas comprising trisilane and a germanium precursor.” *See* Claim 20 (emphasis added). Thus, dependent Claims 21 and 23 (which ultimately depend from Claim 20) also recite “a deposition gas comprising trisilane.” *See* Claims 21 and 23 (emphasis added; *see also* 35 U.S.C. § 112, fourth paragraph). In contrast, the Todd Declaration at ¶ 26 states that “the germanium concentration in the SiGe film is not a linear function of the germane concentration in the gas phase when using either silane or disilane as the silicon source.” *See* Todd Declaration at ¶ 26 (emphasis added).

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In other words, Claims 21 and 23 do not contradict ¶ 26 because Claims 21 and 23 recite trisilane, whereas ¶ 26 refers to silane or disilane. To the contrary, the linearity obtained with trisilane is highly unexpected in view of the non-linearity obtained with traditional silicon precursors such as silane and disilane as explained in the Todd Declaration:

28. The effect of trisilane on germanium incorporation and flow rate is highly unexpected in view of the long-standing art-recognized problem of non-linear Ge incorporation when using germane with traditional silicon precursors such as silane. Thus, the use of a deposition gas that contains trisilane greatly simplifies the task of depositing a graded Si-containing film using thermal CVD because such use of trisilane facilitates substantial linearity of Ge incorporation and deposition rate.

Todd Declaration at ¶ 28. Applicant respectfully submits that a careful reading of the claims and the Todd Declaration shows that the Office has erroneously alleged that Applicant submitted a false declaration.

Because the allegation is based on a factual error by the Examiner, Applicant requests that the Examiner officially and on the record withdraw the allegation that "either the application including the claims (when the claims are given their broadest possible meaning) and specification contain a false declaration or the! [sic] 32 declaration is false." See Office Action at 10. Applicant further advises that the Examiner carefully read and understand an applicant's declaration(s) before making the extremely serious accusation of a "false declaration."

Conclusion

In view of the Amendment to the Claims and Remarks set forth above, Applicant respectfully submits that this application is in condition for allowance, early notification of which would be appreciated. Applicant respectfully invites the Office to contact the undersigned at the telephone number provided below with any questions regarding this application.

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Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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